

Effects of Cinnamon on Blood Glucose among Type 1 and Type 2 Diabetic Individuals: A Comparative Study

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Abstract

Background: Various spices display insulin-potentiating activity in vitro, cinnamon spice in particular. In vivo studies show that cinnamon may have beneficial effects on glucose homeostasis; therefore the aim of this study was to further investigate the proposed health benefits of using cinnamon in humans.

Methods: *Aim.* The present study was designed to investigate effects of supplementation with cinnamon on blood glucose among type 1 and type 2 diabetics. *Sample.* The sample consisted of 60 subjects; 30 subjects with type 1 diabetes and 30 subjects with type 2 diabetes. The doses were distributed equally over the day. Cinnamon was given in the form of powder with breakfast, lunch and dinner. The doses were given for 4 weeks. Blood samples were taken on weeks 0 (starting day of the experiment) 1, 2, 3 and 4. The blood serum glucose of both types 1 and type 2 diabetic groups were determined. The primary statistical analyses included: the two factors (group x time) test, repeated-measures, and ANOVA for defining differences between the two groups over time.

Findings: The mean fasting serum glucose levels for cinnamon doses on weeks 0, 1, 2, 3, and 4 were 241.5, 177.5, 143.83, 137.17 and 126.67 mg/dl for type 1 diabetic individuals, Vs mean fasting serum glucose levels were 254.33, 172.17, 138.17, 126.83 and 127.83 mg/dl for type 2 diabetic individuals. The cinnamon doses significantly ($P < 0.001$) reduced the mean serum glucose levels among both groups.

Conclusions: These data support the efficacy of cinnamon on reducing FBG in type 1 and type 2 diabetes and suggest that this naturally-occurring spice can reduce risk factors associated with diabetes. In light of this research, it is recommended that Type 1 & 2 diabetic individuals should use cinnamon in their food preparations on regular basis along with their antidiabetic medications. This will keep their sugar level near to normal values.

Keywords: Cinnamon, blood glucose, diabetes.

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Introduction

Diabetes mellitus is still a serious health problem all over the world. It is considered the most common metabolic disease worldwide, with an estimated 1700 new cases diagnosed daily.

The W.H.O. estimate of diabetes prevalence for all age-groups worldwide was 2.8% in 2000 and is expected to become 4.4% in 2030. The total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030.¹

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Of these, 85% to 90% have type 2 diabetes mellitus.² Because the disease prevails in both genders and all age groups, the general public has a concern about its control and treatment. In addition to drug treatment, dietary interventions were shown to represent an effective tool to prevent and/or treat insulin resistance and/or type 2 diabetes.^{3,4} Spices like cinnamon, cloves, bay leaves, and turmeric have insulin-potentiating effect *in vitro*.⁵

A number of spices and herbs have a long history of traditional use in treating elevated blood sugar levels.⁶ One such compound that has recently been the subject of intense research is cinnamon, a compound granted GRAS (Generally Recognized as Safe) status by the United States Food and Drug Administration. Cinnamon has been shown to be generally safe when ingested and to have many pharmacological properties; such as antioxidants activity and antibacterial effects.⁷⁻¹⁰ In ancient Egypt, cinnamon was used as a medicine and an embalming agent, and at times it was even considered more precious than gold. It was also popular in China, and is mentioned in one of the earliest books on Chinese botanical medicine.¹¹ Today cinnamon is widely used in Ayurvedic medicine (traditional Indian medicine) to treat diabetes in India. And recently Richard Anderson and his team at the US Department of Agriculture's Human Nutrition Research Center in Beltsville, Maryland, discovered the scientific evidence that demonstrates how cinnamon serves as an important antioxidant, and is beneficial in the prevention and control of glucose intolerance and diabetes.¹²

The beneficial effects of cinnamon on glucose control appear to be in part due to doubly-linked polyphenol type-A compounds.¹² Over the past two decades, *in vitro* and *in vivo* data have been accumulating which support the role of cinnamon on glycemic control. For example, Jarvill-Taylor, Anderson and Graves¹³ reported that cinnamon stimulated glucose uptake, glycogen synthesis, and activated glycogen synthase in 3T3-L1 adipocytes. In rats, cinnamon enhanced glucose uptake by enhancing insulin-stimulated tyrosine phosphorylation of insulin receptor- β , insulin

receptor substrate-1, and phosphatidylinositol 3-kinase in a dose-dependent fashion.^{14,15} To date, human studies demonstrating beneficial effects of cinnamon supplementation on glucose regulation have studied subjects with type II diabetes.¹⁶⁻¹⁸ In a dose-response study, Khan, Safdar, Ali-Khan, Khattak, and Anderson¹⁶ reported that 40-days of supplementation with 1, 3, or 6 grams of whole cinnamon per day resulted in dose-dependent decreases in fasting blood glucose (FBG), and improvements in blood lipid profiles, in subjects with poorly controlled diabetes and dyslipidemia. More recently, Mang et al.¹⁷ reported a 10.3% decrease in FBG after four months of supplementation with a purified aqueous cinnamon extract. Thus, the effects of cinnamon and cinnamon extract on improving insulin signaling and glucose regulation in type 2 diabetics appear promising.

Then, to see how it would work on humans, Alam Khan et al.,¹⁶ who was a postdoctoral fellow in Anderson's lab, organized a study in Pakistan. Volunteers with type II diabetes were given one, three, or six grams of cinnamon powder a day in capsules after meals. All responded within weeks, with blood sugar levels that were on average 20% lower than the control group. Some even achieved normal blood sugar levels. Blood sugar started creeping up again after the diabetics stopped taking cinnamon. Effectiveness of cinnamon supplementation in patients with type 2 diabetes has received a great deal of media attention after the study which was published in 2003. Several clinical trials^{16, 17, 19- 26} have investigated the impact of cinnamon on glucose and plasma lipid concentrations in patients with diabetes but yielded conflicting results and had modest sample sizes. These findings led to widespread cinnamon use, although no study had yet evaluated the effects of cinnamon in Arab diabetic populations with likely differences in diet, BMI, baseline glucose levels, and prescribed medication. Moreover, the efficacy of cinnamon in patients with type 1 diabetes has not been established, many patients seek other therapies and supplement their prescribed pharmacologic therapy with cinnamon. Therefore, we report the first Arab study examining the effects of cinnamon on glucose levels in subjects with type

1 & type 2 diabetes.

Aim of the Study

The purpose of this study was to determine the effects of supplementation with a water-soluble cinnamon on blood glucose among type 1 and type 2 diabetic individuals.

Methodology

Study Design: A pre/post test randomized study design with two parallel groups was utilized to show the impact of cinnamon supplementation on post prandial serum glucose.

Setting: The study was conducted in Al Mafrqa Governmental Hospital.

Sample: Thirty individuals with type 2 and thirty subjects with type 1 diabetes of both genders and of age 40 years or older were recruited for participating in the current study. Only those diabetic subjects, who were not taking medicine for other health conditions and whose fasting blood glucose were in the range of 140-400mg/dl, were included in the study.

Tools: Data for the present study were collected through utilizing the following tools:

1. Demographic Data Sheet: which was developed by the researchers. It included background characteristics of diabetic patients, such as: age, education, type of occupation, marital status as well as period of time they had been diabetic.
2. Fasting Blood Glucose. This serum glucose was measured at baseline and at the end of each consecutive week period (0, 1, 2, 3 & 4).

Procedure: Prior to implementation of the training program, an official permission was obtained from the supervisors of the selected units. This was intended to facilitate data collection and to explain study purpose. At the beginning of the study, participants' were invited to participate in the study. The researchers explained the study purpose and procedures for the randomly selected sample.

Potential subjects were further informed that the participation was voluntary and that study findings would be presented groupwise and no individual would be personally recognized.

The study was conducted for 4 weeks. Type 1 & 2 diabetic individuals were allowed to take their routine diet and usual diabetic medicine. They were further instructed to take 2 grams (approximately one tea spoon) of whole cinnamon powder immediately after breakfast, lunch and dinner for the whole 4 weeks. The research team did not suggest any alterations in other aspects of the subject's medical care, diet, or exercise. Compliance was monitored by contact with the subjects.

Collection of blood samples and biochemical analysis: approximately 3ml blood samples were taken from each individual on day 0, and at end of week 1, 2, 3, & 4 for testing fasting blood glucose level (FBG).

Statistical design: Collected data were tabulated and needed statistical analyses were done utilizing the computer data processing (SPSS, version 12). A probability value (P) of <0.05 was considered to be statistically significant. The analysis proceeded in phases. In the first phase, a descriptive profile of both study groups was done. Glucose outcomes were further analyzed using a general linear model for the two-way ANOVA (two groups x 4 visits) with repeated measures on the time factor.

Results

Sixty subjects of type 1 & 2 diabetes were randomized into the study (30 subjects each). The sample had a mean age of 59 years (SD = 10) with 32 (53%) patients aged ≤60 years. Thirty-seven patients (61.7%) were male and 19 (31.7%) were unemployed or retired. The majority were married (88.3%). Over the half had completed secondary education level (56.7%). The mean period of time since diabetes was diagnosed was 16 years (SD = 9). (Table 1)

Repeated measure ANOVA was used to assess the effectiveness of Cinnamon among type 1 and type 2 diabetic individuals by examining blood glucose changes across time between both groups. Group and time were treated as between- and within-subjects independent variables, respectively.

Table (1): Socio-demographic Characteristics of Diabetic Study Participants (N= 60).

Variable	No. (%)
Gender	
Male	37 (61.7%)
Female	23 (38.3%)
Age	
	59 (SD=10)
Employment	
Employed	41 (68.3%)
Unemployed	19 (31.7%)
Marital Status	
Single	4 (6.7%)
Married	53 (88.3%)
Widow	3 (5.0%)
Education	
Illiterate	3 (5.0%)
Primary Education	5 (8.3%)
Secondary Education	34 (56.7%)
University Education	18 (30.0%)
Period of Time since Diabetes	
	16 (SD=9)

The effect of cinnamon on FBG levels of diabetic individual is shown in table 2. The FBG values on day 0 indicate the serum FBG of diabetic individuals before the start of cinnamon. So, these FBG levels were the control values for the study.

Table (2): Fasting Blood Glucose for Type 1 and Type 2 Diabetic Study Participants.

FBGL	Type 1		Type 2	
	Mean	SD	Mean	SD
Baseline	241.5	36.70	254.33	46.81
Week 1	177.5	33.70	172.17	28.21
Week 2	143.83	13.94	138.17	9.87
Week 3	137.17	9.97	126.83	7.13
Week 4	126.67	6.99	127.83	7.84
Time	137.55***			
F Group	.184			
T*G ^a	5.21**			

^a Product of time by group

* p<.05, ** p<.01, ***p<.001

On the starting day of the experiment (day 0), the mean serum FBG levels of the diabetic individuals of the two groups, were 241.5 mg/dl and 254.33 mg/dl, respectively. After the diabetic individuals of type 1 and type 2 started cinnamon doses, their mean serum FBG dropped to 126.67 mg/dl and 127.83 mg/dl, respectively at week 1. The reduction in the mean blood FBG was significant (P<0.05) from the mean fasting blood glucose in both groups.

Moreover, both groups achieved more reduction in fasting blood glucose level over the study consecutive weeks. Their mean fasting blood glucose level continued to drop to 143.83 mg/dl and 137.17 mg/dl, respectively at week 2; to 137.17 mg/dl and 126.83 mg/dl, respectively at week 3; and 126.67 and 127.83 at week 4, respectively. The data indicated that longer use of cinnamon was more beneficial than shorter use for FBG reduction in diabetic individuals.

This conclusion was supported by the repeated measure ANOVA (F) test. The product term for (group by time), as shown in table 2, was statistically highly significant (F= 5.21, P<.01), and so was the main effect for time (F= 137.55, at p<.001), which supports the beneficial effect of cinnamon intake on improving blood glucose of both groups.

Discussion

A number of spices and herbs have a long history of traditional use in treating elevated blood sugar levels.⁶ One such spice that has recently been the subject of intense research is cinnamon. Over the past two decades, *in vitro* and *in vivo* data have been accumulating to support the role of cinnamon on glycemic control. To date, human studies demonstrating beneficial effects of cinnamon supplementation on glucose regulation have studied subjects with type 2 diabetes.¹⁶⁻¹⁷

The present study shows that 4 weeks of cinnamon supplementation does improve plasma glucose in patients with type 1 as well as patients with type 2 diabetes.

Khan et al.¹⁶ presented the first data on the effects of cinnamon supplementation in humans. In their study, 60 patients with type 2 diabetes (aged 52.2 ± 6.3 y) consumed 1, 3, or 6 g of cinnamon or placebo daily for a period of 40 days. Cinnamon consumption led to a major reduction in fasting serum glucose (18-29%), triacylglycerol (23-30%), LDL (7-27%), and total cholesterol (12-26%) concentrations in each of the cinnamon supplementation trials. Consequently, the authors¹⁶ concluded that small amounts of cinnamon likely represent a safe and effective means to reduce the risk factors for the development of co-morbidities associated with type 2 diabetes.

In the present study, we investigated the effects of short- cinnamon use (6 g/d) on fasting blood glucose. Consumption of cinnamon for 4 weeks significantly ($P < 0.05$) lowered the mean fasting blood glucose levels of diabetic individual of both type 1 & type 2 groups as compared to their mean blood values at the start of the experiment (day 0). This trend was justified as cinnamon was potentiating the function of insulin in carbohydrate metabolism. Khan, Bryden, Polansky and Anderson⁵ has reported that an unidentified factor is present in cinnamon that potentiates the action of insulin in carbohydrate metabolism. They termed this factor as insulin potentiating factor (IPF). Recently, Broadhurst, Polansky and Anderson⁶ reconfirmed the presence of such factor in cinnamon.

Anderson et al.²⁷ characterized this unidentified factor present in cinnamon as methylehydroxy chalcone polymers (MHCP). They explained that MHCP made fat cells more responsive to insulin by activating the enzyme that causes insulin to bind to cells (insulin-receptorkinase) and inhibiting the enzyme that blocks this process (insulin-receptor-phosphatase) leading to maximal phosphorylation of the insulin receptor, which is associated with increased insulin sensitivity.

Moreover, the mean fasting blood glucose levels of diabetic individuals of all the 2 groups were significantly ($P < 0.05$) lower, when they used cinnamon doses for 4 weeks, than when they used cinnamon doses for 1, 2, or 3 weeks, showing that longer use of cinnamon was more beneficial than shorter use of cinnamon. The improvement in glucose regulation observed in this study was significant in and of itself, but it was also significant vis-à-vis the results of other studies of a similar nature. Ziegenfuss, Hofheins, Mendel, Landis, and Anderson²⁸ trial with diabetic adults in Germany, showed less pronounced, but still noteworthy, results with a water-soluble cinnamon extract that was equivalent to 3 g/day of whole cinnamon powder. Their findings indicate that consuming cinnamon for 12-weeks leads to significant improvements in several features of the metabolic syndrome (i.e., fasting blood sugar, systolic blood pressure, and body composition). The observed reduction in FBG in their study is less than that of Khan et al.¹⁶ and similar in magnitude to Mang et al.¹⁷ Mang et al. supplemented 79 people with type 2 diabetes from Germany with 3 g/d cinnamon powder or a placebo for four months.

Previously shown trials revealed a marked insulin-mimetic effect of cinnamon powder, resulting in improved blood glucose regulation. Other trials^{20,21} showed somewhat different results, and sometimes contradictory results, a matter that may depend on how the many variables involved affect one another. Vanschoonbeek Thomassen, Senden, Wodzig, and van Loon²¹ reported no effect of 1.5 g/d x 6 wk cinnamon powder on indices of glycemic control (FBG, insulin, oral glucose tolerance test

[OGTT], HBA, insulin sensitivity, and insulin resistance) in 25 postmenopausal women from the Netherlands. This study was different from that of Khan et al.¹⁶ and Mang et al.¹⁷ (as well as the current study) in that only postmenopausal females were included as subjects. Whether differences in hormonal milieu affect the potential interaction between cinnamon supplementation and glucose control or not is still unknown at this time. In addition, there were apparent differences in the baseline values of fasting glucose between the subjects participating in those studies. Baseline values for fasting glucose and higher in the cohort described by Khan et al. (>11.4 and > 2.25 mmol/L, respectively) compared with Vanschoonbeek et al.²¹ study population (8.3 and 1.26 mmol/L, respectively). These differences could likely be responsible for the discrepant findings in Vanschoonbeek et al. study.

The current study further showed that the differences in fasting plasma glucose levels between the pre- and post- intervention were significant for both diabetes groups. Type 2 diabetic group, however, had a significantly greater decline in plasma glucose levels from pre- to post-intervention than did the type 1 diabetic group. On the contrary to our study results especially among type 1 diabetics and in an argument for the evidence of effectiveness of cinnamon, Altschuler and colleagues¹⁹ recently published additional prospective research concluding that there is significant doubt regarding the efficacy of cinnamon in patients with type 1 diabetes. Altschuler, Casella, MacKenzie, and Curtis¹⁹ explained their negative result in light of mechanistic differences between type 1 and type 2 diabetes, i.e., the lack of endogenous insulin production in the former. They further attributed¹⁹ their negative results among type 1 diabetics to the fact that their subjects received an inadequate dose of cinnamon. Their study dose was based on the previously demonstrated benefit of 1 g/day.¹⁶ Perhaps, although sufficient for type 2 diabetic subjects, this is an inadequate dose for those with type 1 diabetes.

Vanschoonbeek, Thomassen, Senden, Wodzig, and van Loon²¹ used 1.5 g/day and failed to demonstrate a benefit, whereas Mang, et al.¹⁷ used 3 g/day and did demonstrate improvement in fasting glucose. However, according to the data Khan et al.¹⁶ presented, both 1 g/day and higher doses were effective. Moreover, Altschuler et al.¹⁹ further added that it is also possible that participants were not given cinnamon for a long enough duration. Because 90 days is less than the full 120-day lifespan of red blood cells, perhaps this shorter duration contributed to a false-negative result. However, we believe that 90 days is a sufficient time in which to demonstrate an effect and also point out that these results are consistent with other recent observations.^{17, 21}

In summary, current study provides evidence that cinnamon is effective in improving glucose level among both type 1 and type 2 diabetic individuals. Coupled with other recent research, our results demonstrate positive effect on fasting blood glucose that introduces significant remarks regarding the efficacy of cinnamon in diabetic subjects. In light of this research, it is recommended that diabetic individuals should use cinnamon in their food preparations on regular basis along with their antidiabetic medications. This will keep their sugar level near to normal values.

Conclusion and Recommendations

Based on the results of this study, cinnamon may play a beneficial role in ameliorating the effects of several chronic diseases of modernization. Current study data support the efficacy of cinnamon supplementation on reducing FBG, when consumed for at least 4-weeks. More research on the proposed health benefits of cinnamon supplementation is warranted before health claims should be made. Studies should be conducted to determine how specific variables (diet, ethnicity, glucose levels, cinnamon dose, and concurrent medication) affect cinnamon responsiveness. Finally, although it is acknowledged that we used a relatively small, homogeneous sample of subjects, cinnamon appears to be reasonably safe at the dose and duration studied. Larger, longer-term multi-center

studies are necessary to confirm our findings, and determine the mechanism(s) underpinning the observed physiological effects.

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تأثيرات السينامون على مستوى الجلوكوز بالدم لدى مرضى السكري من النوع الأول والثاني: دراسة مقارنة

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الملخص

استقصت بحوث كثيرة تأثير التوابل باختلاف أنواعها في عملية تنشيط الأنسولين خارج الجسم، وبشكل خاص، تابل السينامون (القرفة). أما عن تأثيرها على السكر داخل الجسم فقد أوضحت الدراسات أن القرفة ربما يكون لها تأثيرات مفيدة على توازن الجلوكوز؛ لذا هدفت هذه الدراسة إلى تحري الفوائد الصحية المحتملة لاستعمال السينامون بين مرضى السكري ودراسة هذه الفوائد.

الطرق المستخدمة: قامت الدراسة الحالية بتحري التأثيرات الناتجة عن السينامون (القرفة) على الجلوكوز في الدم بين مرضى السكري من النوع الأول والنوع الثاني. واشتملت عينة الدراسة على 60 مريضاً؛ منهم 30 مريض سكري من النوع الأول، و30 مريض سكري من النوع الثاني. اختيرت هذه العينة بطريقة عشوائية، ووزعت كمية السينامون بطريقة متساوية خلال اليوم حيث تم أخذها على شكل مسحوق ملء ملعقة شاي بعد الفطور وبعد الغداء وكذلك العشاء. كما تم إعطاء هذه الجرعة لمدة أربعة أسابيع. وتم سحب عينات الدم لفحص مستوى الجلوكوز على النحو التالي: يوم بدء التجربة (الأسبوع 0)، وفي نهاية الأسبوع الأول، ثم الثاني، والثالث، وأخيراً الأسبوع الرابع. شملت التحليلات الإحصائية الأساسية متغيرين أساسيين وهما عاملا (المجموعة X الوقت)، لإجراء تحليل الاختلافات متعدد القياسات Repeated Measure ANOVA.

النتائج: أظهرت النتائج أن متوسط مستوى الجلوكوز الصائم في أسابيع 0، 1، 2، 3، و4 كانت 143.83، 177.5، 241.5، 177.5، و137.17 و126.67 مج/لتر المكعب لمرضى السكري من النوع الأول، بينما كانت مستويات الجلوكوز الصائم بنفس الأسابيع 254.33، 172.17، 138.17، 126.83 و127.83 مج/لتر المكعب لمرضى السكري من النوع الثاني. وقد كان للسينامون تأثير بشكل ملحوظ (بي > 0.001) أدى لخفض مستويات الجلوكوز بين كلتا المجموعتين.

الإستنتاجات: تدعم هذه البيانات كفاءة السينامون (قرفة) على خفض مستوى الجلوكوز بين مرضى السكري من النوع الأول والثاني، وتقترح بأن هذا التابل يمكن أن يخفض عوامل الخطر التي ترتبط بمرض السكر. وعلى ضوء هذا البحث، فإنه يوصي بأن مرضى السكري من كلا النوعين يجب أن يستعملوا 1-3 جرام يوميا من السينامون في تحضيرات غذائهم وبطريقة منتظمة. كما يوصى البحث بإجراء دراسات أخرى لاختبار العلاقة بين جرعات السينامون المختلفة والتأثيرات الناتجة المحتملة بين مرضى السكري.

الكلمات الدالة: سينامون، قرفة، جلوكوز الدم، مرض السكري.